2005 National Software Conference

Software Conformity Experiences

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Background

- When requested to develop this presentation, my immediate reaction was, “If they want to know about conformity, they should go see the presentation Dennis Wallace is doing…”

- However, after reflecting on the subject of “conformity”, I decided there was not much I could do that would make things more confusing

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Overview

- This presentation will talk about one DER's journey down the "software conformity" path in hopes it will ease the way for someone else

- The presentation will include extracts from the following sources:
  - Regulatory guidance
  - OEM experience (BizJet and Air Transport)
  - Supplier experiences

- Data presented will draw from the following:
  - Regulatory material
  - ACO/Manufacturer conformity agreements
  - Software conformity checklists

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Introduction

- I started down the DER path a number of years ago while working at a TSO and PMA house…
  - "Conformity" was more or less equivalent to "configuration control" and recording a configuration
  - As my career changed, so did my understanding of "conformity" involving software
- For some conformity issues, "configuration control" is an adequate definition – for other types of conformity, it is not a ***complete*** definition
- ***Configuration control*** will always be ***one aspect*** of "conformity"

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Introduction

- There are lots of terms out there regard to “software conformity” including conformity reviews, conformity inspections, installation conformity, and on and on

- As well, the term “conformity” may mean different things depending on the context and who is using the term

- Our goal today is to understand a couple of different contexts for “conformity” and focus only on aspects that a DER may be involved in “signing off” – if we can do that, the topic of conformity gets simpler

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Setting the context for conformity

- Understanding the context is necessary – some of the questions we might want to ask about “conformity” are:
  - Why does the part or device need to be conformed?
  - Who is asking for the conformity?
  - What is the current status of the part or device being conformed?
    - » TSO’d?
    - » Previously approved through a TC/STC process?
    - » Under development?
    - » Modification to an existing TSO or previously approved device?
- The previous questions will help us define what we mean by “conformity”

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Setting the time (phase) for conformity

- **So, when do we need “conformity”?**

Anytime we are doing an “FAA Test”

- OK, now we have to figure out what is an “FAA Test” and what is not an “FAA Test”

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Reference material

§ FAR 21.33 Inspection and tests.

(a) Each applicant must allow the Administrator to make ***any inspection and any flight and ground test necessary to determine compliance with the applicable requirements of the Federal Aviation Regulations.*** However, unless otherwise authorized by the Administrator —

(1) ***No aircraft, aircraft engine, propeller, or part thereof may be presented to the Administrator for test unless*** compliance with paragraphs (b)(2) through (b)(4) of this section has been shown for that aircraft, aircraft engine, propeller, or part thereof; and

(2) No change may be made to an aircraft, aircraft engine, propeller, or part thereof between the time that compliance with paragraphs (b)(2) through (b)(4) of this section is shown for that aircraft, aircraft engine, propeller, or part thereof and the time that it is presented to the Administrator for test.

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Reference material

(b) Each ***applicant must make all inspections and tests necessary*** to determine—

(1) Compliance with the applicable airworthiness, aircraft noise, fuel venting, and exhaust emission requirements;

(2) That materials and products conform to the specifications in the type design;

(3) That parts of the products conform to the drawings in the type design; and

(4) That the manufacturing processes, construction and assembly conform to those specified in the type design.

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Conformity concepts

There are two key concepts in FAR Part 21, Section 33*

Presented to the Administrator for test…

Comply with type design…

These two concepts are the “heart and soul” of “conformity”

* *There is a very similar set of regulations for propellers and engines in FAR 21.53*

So, what kinds of tests would the "Administrator" be interested in?

From Order 8110.4b…

2-11(c)(5)(d)(3) An applicant must allow the FAA to make any inspection and ***any flight or ground test necessary to determine compliance with the applicable requirements of the Federal Aviation Regulations.*** However, the applicant makes all inspections and tests necessary to show compliance prior to presenting the product to the FAA for testing (reference § 21.33).

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Setting the context for conformity - Testing

- Ground or flight test to ***determine compliance with*** … ***FARs***…

- The term "***compliance with FARs***" would indicate work being done for some type of certification project (TC/STC/ATC)

  – Is a Technical Standard Order (TSO) a FAR?

  – Are TSO Minimum Operational Performance Standards (MOPS) considered FARs?

  – Does type design data need to comply to the FARs?

  – Could a TSO MOPS be called out in "type design data" that would need to comply with the FARs?

- Which of the above would be a consideration when getting ready to "do a conformity"?

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Setting the context for conformity - Testing

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Setting the context for conformity - Testing

- ***Ground or flight test*** to determine compliance with … FARs…

- Ground or flight test sounds pretty easy – what are some examples that would fit that category?

  - Abnormal, in-air flight control recovery tests
  - HIRF and Lightning tests (special conditions for TC/STC/ATC)
  - Qualification tests (DO-160 tests) for TC/STC/ATC
  - Software verification tests (DO-178B compliance)
  - TSO MOPS compliance tests for TSOA
  - Qualification tests (DO-160 tests) for TSOA

- Which, if any, would be a consideration in “doing a conformity”?

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Setting the context for conformity - Testing

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  - Software verification tests (DO-178B compliance)
  - TSO MOPS compliance tests for TSOA
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- Which, if any, would be a consideration in “doing a conformity”?

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TC/STC/ATC versus TSOA

- We worry about “conformity” for activities in support of TC/STC/ATC
- We don’t worry about “conformity” for activities in support of TSOA
- But there is a catch…

There are few TSO’d devices that don’t eventually get into a TC/STC/ATC effort!

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TC/STC/ATC versus TSOA

- What about devices which are, or will be TSO'd (new or changed), that will be going into a TC/STC/ATC program?

- For changes to existing TSO'd devices ***it may depend on the ACO*** where the TC/STC/ATC work is being done but generally…

  TC/STC/ATC work will trump the in-progress TSO work – the certification program will require "conformity" for devices not yet TSO'd (new or changed)

- If the device has its TSOA, there will still be "conformity work" but the nature of the "conformity work" will change (lessen) in support of TC/STC/ATC activities

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You will conform…

- So if the device is going into an “FAA test”, it will require conformity – no debate

- Knowing that “conformity” is required, what is to be done?

- From a DER (engineering) perspective, we must ***show the device complies its type design data***

And for software, things go downhill from there…

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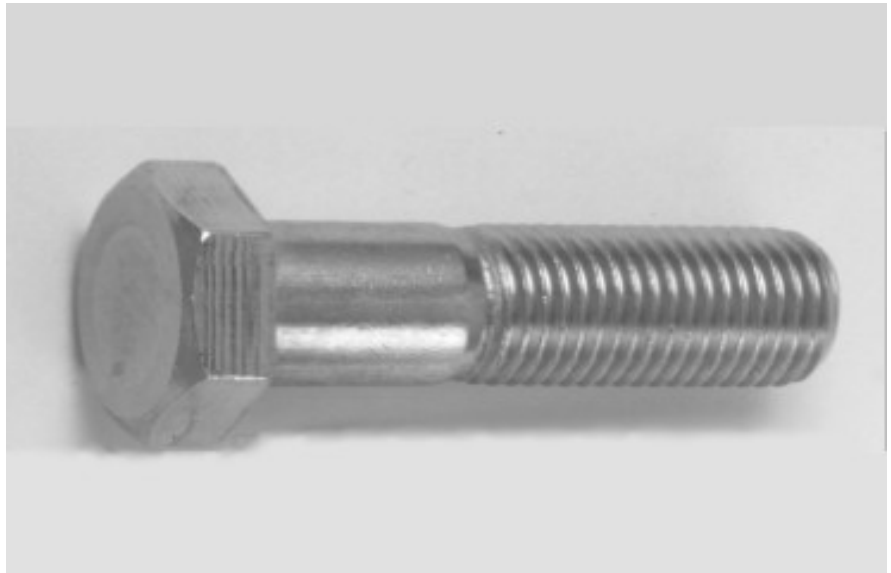
Let's get physical…

- If we wanted to "conform" something as simple as a bolt (ensure it satisfies type design data), we could:
  - Measure the various diameters
  - Measure the various lengths
  - Measure the pitch
  - Verify hardness
  - Verify material
  - Verify finish
  - Verify elasticity
  - X-ray it
  - and even destructively test it



- How can we do something similar for software? We can't touch, we can't measure it, we can't test it without trying it out, it takes a long time to build…

- Like or not, we may have to rely on a process of some kind…

- For software, type design data is:

From RTCA/DO-178B

9.4 Software Life Cycle Data Related to Type Design
Unless otherwise agreed by the certification authority, the regulations concerning retrieval and approval of software life cycle data related to the type design applies to:

- Software Requirements Data
- Design Description
- Source Code
- Executable Object Code
- Software Configuration Index
- Software Accomplishment Summary

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Reference Material

- So how do we show all the type design data “stuff” cited in RTCA/DO-178B is satisfied?

From Order 8110.49…

4-2. DISCUSSION. A conformity inspection is required to determine that the applicant complies with 14 CFR § 21.33(b) and that the product and components conform to approved type design.

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Determination of an applicant’s compliance to software type design is largely assessed through ASE or DER (if authorized) reviews throughout the software development life cycle; the details of which are presented in chapter 2 of this order.

Note:

“Chapter 2 of this order” refers to the SOI reviews and suggests use of the job aid

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But I can't get there from here!

- At this point things ***may*** get "ugly"…
- When it is time to start qualification testing, or even HIRF & Lightning testing, it is unlikely the software will have been able to satisfy all of the criteria for an SOI 2 let alone an SOI 3 review
- So what do we do? For a TC/STC/ATC program, these are clearly FAA tests yet we cannot show the "type design" has been satisfied*****

*** As DERs, we typically indicate compliance for software via an 8110-3 citing the appropriate life cycle data with a finding under 25.1309(a) or similar guidance for Parts 24, 27,or 29.**

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How can we take a legal detour?

- If FAA testing has to start (there is always a schedule even if you are a DER), Order 8110.49 and 8110.4b both provide hints on how to proceed even though software development may not be complete…

From Order 8110.49…

NOTE: In some cases, special purpose software is used for environmental qualification testing. When this is the case, the manufacturer must verify, validate, and control the configuration of the special purpose test software. The test software should be included as part of the test setup conformity conducted before the qualification testing.

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How can we take a legal detour?

From Order 8110.4b…

2-11(c)(5)(d)(1)(d) It is strongly recommended that an applicant make and submit to the FAA a certification plan for all type certification projects. The plan should be submitted early in the project and updated throughout the project. As a minimum, the Certification Plan should contain the following information:

2-11(c)(5)(d)(1)(d)5 Project schedule, including major milestones, preliminary hazard analysis submittal, detail submittals, when conformity and testing are required, and when final certification is expected.

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A potential detour…

- One possible approach is outlined below:
  - Propose several different types of conformity processes for ***approval of engineering data related to type design***
    - » Establish a conformity process for qualification testing
    - » Establish a conformity process for HIRF & Lightning testing (special conditions)
    - » Establish a final type of conformity process for aircraft level tests (ground and air tests)
  - Entry criteria for each conformity process would become progressively more difficult as the software and system matures

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Qualification testing

- For qualification testing, something like the following configuration controlled items could be considered for entry criteria (parallels guidance for a software verification tool):
  - Requirements document defining how the software should perform (the objective may be to monitor hardware as opposed to normal functional operation)
  - Source code
  - Executable object code
  - Acceptance test procedure to demonstrate the software functions properly (may be quite high level)
  - Acceptance test results showing the acceptance test procedure passed
  - Software configuration index or equivalent including information appropriate for the Software Life Cycle Environment Configuration Index and software loading procedures

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HIRF and Lightning testing (special conditions)

- Presumably the software has matured as HIRF & Lightning testing (special conditions) is ready to start – as such, the entry criteria becomes more difficult with the following configuration controlled documents…
  - Approved planning documents (PSAC, SDP, SVP, SQAP, SCMP)
  - Baselined Software Requirements Document
  - Baselined Detail Design Document
  - Source code
  - Executable object code
  - Requirements based test procedures and results
  - Software configuration index document or equivalent including information appropriate for the Software Life Cycle Environment Configuration Index including software loading procedures
  - Software accomplishment summary or equivalent including known limitations, functional deficiencies and test deficiencies

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Aircraft level testing

- By the time we get to actual aircraft level ground and flight tests, we should be very close to the final software configuration – at that point, it is not unreasonable to expect the following configuration controlled items:
  - All of the data required for HIRF and Lightning (see previous slide)
  - Safety of flight test procedures and results
  - Completed SOI 1, 2 and 3 reviews (or if a delta conformity, completed regression analyses and reviews)
  - Documented analysis of all open PRs for potential impact to flight test
  - As well, and outside the scope of this presentation, the hardware the software is loaded on should be representative of type design

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Logistics

- Assuming you chose to define a phased approach to conformity, where would you document the approach to solicit FAA concurrence?
  - There are several possible places to work these kinds of agreements including the following (presented in order of preference)
    - » Aircraft certification plan
    - » FAA/applicant white papers (essentially formal correspondence)
    - » Issue papers
  - Ideally, you would capture the approach in the certification plan – unfortunately, the latter two forms of agreement often don't get kicked off until the project is getting desperate in terms of schedule
  - Larger OEMs will likely have a template for conformity they will use over and over – smaller players will likely struggle more since they don't go through the conformity process as frequently (but they could develop a template)

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What we have not talked about…

- Conformities involving TSO'd boxes (tends to be a configuration control check)
- Incremental conformities – just say no!
- Installation conformity – does the device or airplane have the correct software loaded and how would one know?
- What software changes might do HIRF and Lightning (special conditions) baselines
- Inter-ACO or inter-certification authority issues
- MIDOs – particularly if there is are inter-region or inter-authority issues
- ODARS and DMIRs

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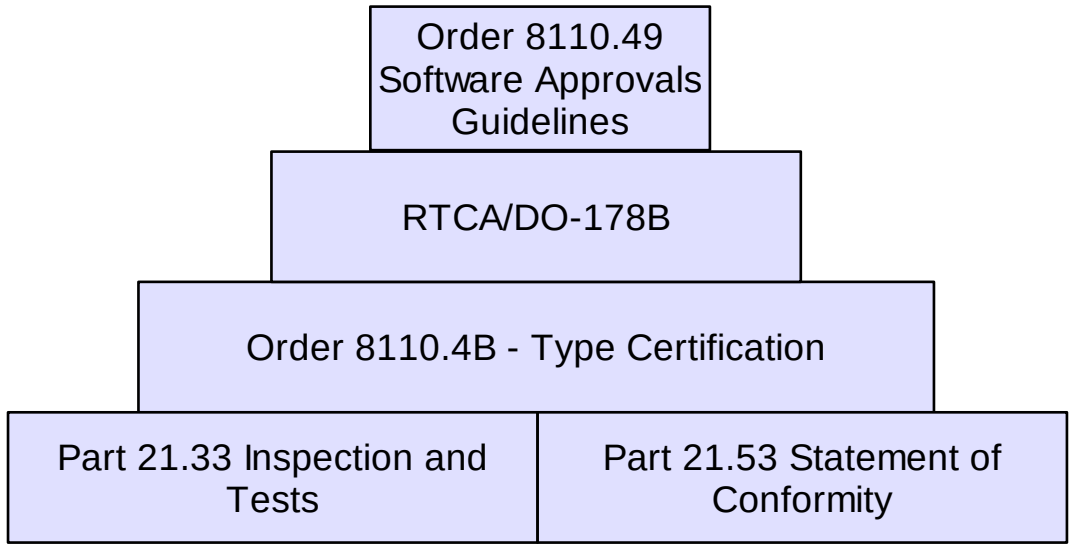
Wrap up

- Software conformity can be confusing – with any luck the past 45 minutes may have helped
- Fundamental guidance is found in Part 21.33 and 21.53, further elaborated in Order 8110.4B and finally tailored for software through RTCA/DO-178B and Order 8110.49
- Consider defining different types of conformity processes to facilitate FAA testing
- No matter what you do, coordinate with the appropriate certification authorities early and often



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This is a start – you will learn more as you get further involved…